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PREVALENCE OF PESTICIDE RESIDUES IN FISH, CHEESE AND HUMAN MILK

(With 6 Tables)

By

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مدى تواجد بقايا المبيدات في السمك والجبن ولبن الأم

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تهدف هذه الدراسة إلى تقدير بقايا المبيدات في (السمك ـ الجبن الجاف ـ لبن الأم) حيث تم تجميع ٧٨ عينة خلال ١٢ شهراً من أربع محفظات (القاهرة ـ أسيوط ـ دمياط ـ المنوفية). حيث أشارت النتائج إلى تلوث الأسماك المجمعة من أسيوط والمنوفية ببعض هذه المبيدات ، ووجد أن متوسط التلوث بالأندرين + الداي الدرين كانت ٠,٢٣ ، ٠,١٧٧ ، ومركبات DDT, كانت ٠,١٣ ، ١,٥٩ HCH، كانت ١,٦٢ ، ٠,٧٣ جزء في البليون من أسيوط والمنوفية على التوالي. وبالنسبة للجبن الجاف فقد وجد أن P'P' - DDT أكثر الملوثات توزيعا والأكبر تركيزاً للعينات المجمعة من محافظات أسيوط ، القاهرة ودمياط حيث كان متوسط تركيز هذا الملوث ١,٩١ ، ١,٧ ، ١,٣١ جزء في البليون. ومستويات التلوث بكل من الليندان والألدرين + الداى‌الدرين كانت أكثر من الحد الأقصى المسموح بها في كل عينات الجبن المجمعة. وأشارت النتائج المتحصل عليها أن ٦ عينات من ١٠ عينات من لبن الأم كانت ملوثة بالـ DDT (بتركيز ١٧-١٧٦ جزء في البليون) وخمسة عينات ملوثة بال HCH بمتوسط تركيز ٣٣,٦ جزء في البليون ، ولكن ثلاث عينات فقط أظهرت التلوث بتركيزات ضئيلة من الأندرين + الداي الدرين بمتوسط ٣٠,٥ جزء في البليون ، وبتقدير الجزء المتناول يومياً (ADIs) من هذه الملوثات بالنسبة للأطفال الرضع ومقارنتها بالحدود المسموح بتناولها يوميا (ADIs) من هذه الملوثات وجد أن EDIs من مركبات DDT واللنيدان كانت أقل من ADIs. فيحين كانت EDIs للأندرين + الدلدرين أكثر منها في حالة ADIs.

SUMMARY

Pesticides constitute the major source of potential environmental hazard to man and animal as they are present and concentrated in the food chain. This investigation was conducted on 78 samples of fish, hard cheese (Ras cheese) and breast milk collected randomly from four governorates of Egypt over a period of 12 months and analyzed to establish their contamination levels with organochlorine pesticides. The results obtained indicated that the mean value of (endrin+dieldrinc);∑ HCH and ∑DDT were 0.23, 0.177, 0.13, 1.59, 1.62 and 0.73 in fish samples collected from Assiut and El monifiah, respectivaly. P'P'-DDT revealed the highest level and frequency in hard cheese with mean values 1.91,1.7 and 1.31 ppb for the samples collected from Assiut, Cairo and Domitta governorates respectively. The level of lindane and Aldrin + dieldrin were higher than the MRL in all cheese samples collected. On the other side 6 Breast milk of 10 samples were positive for DDTs (17- 176 ppb) and five samples containing ∑HCH with mean value of 33.6 ppb. But three samples only recorded detectable level of Endrin + dieldrin with mean value 30.5 ppb. Estimated dietary intakes (EDIs) of these contaminants by the breast-fed infants were compared to acceptable daily intake (ADIs). EDIs of DDT complex and lindane, α HCH were below ADIs. Endrine + eldrine EDIs exceeded the acceptable daily intake.

Key words: Monitoring- organochlorine pesticides (OCPs) -fish-hard cheese-breast milk – EDIs.

INTRODUCTION

The use of organochlorine pesticides (OCPs), has been restricted or banned in many countries since the 1970s. However, they are still used to control vectors of borne diseases in public health programs in many tropical and subtropical countries. The ban of organochlorine pesticides, like DDT and technical HCH, was based on their persistence in the environment. Evidence has been given that they could be passed through food chains is major importance as they accumulated in human body and subsequent secretion of stored residues into human milk as a main route for their excretion (Waliszewski *et al.*, 1995 and 1997). As well as Muir *et al.*, 1990 and Hmh, 1990 reported the incidence of OPCs in fish.

In Egypt, the use of chlorinated hydrocarbon pesticides has been banned since the early 1970s. However high detectable amounts of these chemicals in milk and dairy products, fish and human milk were recorded (Dogheim *et al.*, 1988, Abd Allah *et al.*, 1990; Ahmed & Ismail, 1991; Dogheim *et al.*, 1991; Abdalla *et al.*, 1993; Dogheim *et al.*, 1996a; Abd Alla *et al.*, 1997; Abd Alla *et al.*, 19898; Osfar *et al.*, 1998 and Dabeiza *et al.*, 1999).

Longnecker *et al.*, (1997) reported that exposure to selected organochlorines appears to cause abnormalities of liver function, skin "chloracne" and the nervous system. They added that many of them are endocrine disrupters or carcinogens Veer *et al.*, (1997) linked between exposure to organochlorine pesticides and altered sexual development in various species, decreased semen quality and increased risk of breast cancer in women.

The present paper was done to investigate the contamination of hard cheese and Egyptian human milk with organochlorine pesticides (OCPs). And to estimate the dietary intakes of organochlorines (EDIs) by breast – fed infants.

MATERIAL and METHODS

SAMPLE COLLECTION:

Seventy eight samples were used for this study. Fish (23) and hard cheese (45) were collected from (Assiut; Cairo; Domiatta and El-Monifiah governoretes).Samples were collected randomly during the period between March 1999 to April 2000. Also 10 samples of breast milk were obtained of 10 donors from out patient clinic Abo El- Rish Hospital-Cairo University in September 1999. Samples were immediately cooled down, and milk fat layer was separated by centrifugation. All cheese and milk samples were kept, frozen at – 20°C until analyzed.

REAGENTS:

(a) Pesticide reference standards: Organochlorine pesticides were obtained from Environmental Protection Agency (EPA). All the standards were prepared according to AOAC (1990).

(b) Solvents and chemicals: Chemicals and solvents (pesticide residue grade), were purchased from Merck Company, Germany.

(c) C18 – Cartridges: Octadecyl (C18) bonded silica cartridges (500 mg/ 3 ml) were products of chromabond and chromafil – Macherey – Nagel – Düren - Germany.

GAS CHROMATOGRAPHY APPARATUS:

The capillary gas chromatograph with Ni63 electron capture detector (ECD) and flame photometric detector (FPD), was Hewlett – Packard Model 5890 A with an automatic injector and Capillary Column (HP 101, 25 m x 0.2 mm x 0.2 µl methyl silicone).

ANALYTICAL PROCEDURE:

a- Fish and Cheese: Melted fat (0.5 g) was dissolved in 1 ml ethyl acetate at 5^0C and 4 ml absolute methyl alcohol were added. The tubes were kept in an ice bath to precipitate fat and the clear supernatant was removed. C18- cartridge (500g) was preconditioned with 1 ml n-hexane followed by 1 ml methanol. Aliquot (0.5 ml) of the sample extract was sucked or pressed through the cartridge, washed with 0.5 ml acetonitrile; water (1:1 v/v). The cartridge was then dried by applying vacuum for 10 min. the OCPs were eluted from the cartridge with 3 (0.5 ml n- hexane.

b- Breast milk: milk samples were extracted according to the method described by Prapamontal and Stevenson (1991) as follow:

Milk sample (10 ml) was extracted with 10 ml ethyl acetate:methanol: acetone (2 : 4 : 4) and vortexed for 1 min, then the sample tubes were placed in an ultrasonic bath for 20 min. The tubes were centrifuged at 2000 rpm, for 15 min. at 20°C. The total supernatant was aspirated into 500ml conical flasks, (11.5 ml.). C18- cartridge (500 mg) was preconditioned will 2x1ml isooctane, 2x1ml ethylacetate, 2x1ml methanol and 2x1ml distilled water. The vacuum was turned off, and care was taken to keep the cartridge wet. An aliquot of 13 ml of distilled water was added to the sample extract and then passed through the cartridges at a flow rate of 6–8 ml/min. The conical flask was rinsed with 2x1ml distilled water and added to the cartridge. The cartridge was washed with 2x1ml 25 % acetonitrile –water and dried by pulling air through the cartridges for 3 min. The organochlorine pesticides (PCBs) were eluted from the cartridges with 2X0.5 ml isooctane.

Capillary GAS – Liquid Chromatography:

Operating conditions for OCPs was injection port 250°C; detector oven (ECD) 300°C. column, oven programmed for an initial temperature 80°C for 1 min, increased by 30°C/min to 190°C followed by 36°C/min to 250°C and hold for 10 min. Inlet pressure 4.3 psi, which was 40 cm/s gas velocity; splitless injection with purge off for 1 min. Carrier gas, at 60 ml/min, injection volume was 1 µl.

RESULTS and DISCUSSION

1- Contamination of fish with organochlorine pesticides:

The concentration of organochlorine pesticides in Bolti fish (Tilapia) collected from Assiut and El Monifiah Governorates are shown in table (1). As a whole Contamination of fish by organochlorines was in the following order: P'P'-DDT>P'P'-DDD>P'P'-DDE>lindane and α -HCH >β -HCH ; Endrine and dieldrine for Assiut governorate. But it was Endrin > dieldrin > lindane > α -HCH, β -HCH, P'P'-DDT,P'P'-DDD and P'P'-DDE>Heptachor-epoxide for El Monifiah governorate. Where aldrin was not detected in all analyzed samples.

Regarding aldrin, dieldrin, endrin and heptachlor–epoxide. For endrin + dieldrin, all investigated samples collected from El Monifiah showed a higher mean residue levels (0.23 p.p.m) than those collected from Assuit governorate (0.18 p.p.m). On the other side the highest levels were 0.47 and 0.43 for El -Monifiah and Assuit governorates respectively (Table 1). But heptachlor – epoxide was detected in 14.3 % of El Monifiah fish with a mean value of 0 .08 p.p.m (Table 1).

Gamma-HCH (lindane) and α -HCH were found in 18.75 % in fish samples Obtained from Assiut markets but in those collected from El-Monifiah the incidence was 57.1 and 42.9%, respectively as shown in Table (1). β-HCH was found in 42.9 % and 12.5% of El Monifiah and Assiut fish samples respectively. On the other hand, the highest level of HCH isomers were recorded in El Monifiah fish Table (1).

DDT including the residues of P'P'-DDT, P'P'-DDD and P'P'-DDE were determined in the analyzed fish samples. The frequency were 56.25%, 37.5% and 31.25 % for Assiut fish samples, but for those of El-Monifiah fish samples they were 42.9% for each respectively. The mean values of sum-DDT were 1.62 and 0.73 ppm. with highest levels of 4.10 and 1.27 ppm for Assiut and El Monifiah fish respectively (Table, 1).

The chlorinated pesticides levels found in fish samples under investigation are in a good correlation with those of fish samples in Canada, Hong Kong and different areas in Egypt. (Dogheim *et al.*, 1988; Abd allah *et al.*, 1990; Muir *et al.*, 1990; Hmh, 1990; Dogheim *et al.*, 1996 and Osfar *et al.*, 1998).

The mean p'p' -DDT and ∑DDT levels in fish detected were higher than the FAO/WHO Tolerance level of FAO/WHO (1993) and this could be attributed to antimalaria sanitary actions being carried out through the Sudan.

2-Contamination of hard cheese (Ras cheese) with organochlorine pesticides:

The frequency, mean levels and the highest level of pesticides in Ras cheese are presented in Table (2). Aldrin was not detcted in all the analyzed cheese samples. But heptachlor-epoxide was only detected in 6.7% of the positive cheese samples collected from Cairo governerate with a mean value of 0.05 ppm. This mean was higher than the FAO/WHO tolerance level (0.006 ppm.).

The highest frequency (40%) levels of Endrin was observed in cheese samples collected from Assiut followed by Cairo samples 33.3% and 20% for Domitta cheese samples. The same order was found for the mean levels which these were 0.91, 0.37 and 0.17 ppm for Assiut, Cairo and Domitta governorates respectively. Dieldrin residues were detected in 26.7 % and 13.37 % in Cairo and Assiut cheese samples, with an overall mean residue of 0.24 and 0.21 ppm. Those levels were higher than FAO/WHO and ER tolerance level of 0.006 ppm. (Table 5). Dieldrin was not detected in all the samples collected from Domitta.

α-HCH residues were detected in 20, 26.7 and 13.33 % of samples at an overall mean residue of 0.59, 0.42 and 1.05 ppm. β-HCH was only detected in 2 out of 15-cheese samples (13.3 %) collected from Cairo governorate at a mean value of positive samples of 0.89 ppm. This finding is noteworthy because of the long half-life of β-HCH in the human body (FAO/WHO, 1985).

The most important isomer γ-HCH (lindane) was detected in 33.3, 26.7 and 40% of the analyzed samples, with a mean concentration of 1.15, 0.38 and 1.2 ppm for Cairo, Domitta and Assiut governorates, respectively. The mean values of $\sum$ HCH was higher than FAO/WHO and ER tolerance level of 0.01 p.p.m. as presented in Table (5). On the other side, the mean values of $\sum$HCH were 0.88, 0.27 and 0.75 ppm of Cairo, Domitta and Assiut samples respectively which were higher than the FAO/WHO tolerance level of 0.1 ppm. (Table 5). The levels of hexachloro-benzene can be influenced with the environmental contamination with this compound.

Today, agriculture is not the main source of HCH intake. It is supposed that many residues in our ecosystem come from the deposits of chemical wastes (Prachar *et al.*, 1995). These finding also could be due to the use of γ -HCH in anti- livestock ectoparasites.

The frequency of p'p'- DDT was 53.33 % of Assiut cheese samples followed by 46.7 % for Cairo samples, but it was 33.3 % of Domitta

cheese samples. The mean values of 1.91; 1.78 and 1.31 ppm. of cheese samples collected from Assiut, Cairo and Domitta governorates respectively. The frequency of p'p'-DDE was 33.33% for Assiut; and 20% in Cairo and Domitta cheese samples respectively. The mean values were 0.76; 0.096 and 0.28 ppm. for Cairo; Domitta and Assiut samples, respectively. Whereas p'p'- DDD was detected in 26.7 % of Assiut cheese samples with a mean value of 0.014 ppm. The mean total DDT values were 0.85; 0.47 and 0.73 of Cairo, Domitta and Assiut cheese samples respectively, (Table 1). These values were higher than the FAO/WHO tolerance level (0.05 ppm). The main cause of DDT contamination detected in milk and dairy products could be due to consumption of contaminated hay/straw and through inhaled contaminated air by milking animals (Waliszewski *et al.*, 1998).

3- Contamination of Breast milk with organochlorine pesticides:

The organochlorine pesticide residues were extracted from milk fat. The fat content of breast milk ranged from 1.96 to 3.99 with a mean of 2.87%. However endrin and dieldrin were detected in three samples with a mean of 30.5 ppb ranging from 19 to 42 ppb. (Table 3).

DDT complex is the most frequently pesticide found in breast milk samples (60%). The highest frequency of p'p'-DDT was observed in 6 out of 10 samples. However, the presence of p/p/-DDT was found in 4 samples, but P'P'-DDE was detected only in one sample (Table 3). The obtained data revealed that the mean concentration of total DDT complex was 79.2 ppb.

α- HCH isomers were, among pesticide residues identified. The frequency of α-HCH was 50% of the analyzed breast milk samples with a mean value of 13.0 ppb and 30 % of breast milk samples were contaminated with γ-HCH (lindane). Ranging from 21 to 24 ppb. with a mean value of 28.0 ppb. The frequency of β–HCH was 20% of the analyzed samples with a mean value 9.5 ppb (Table 2). The results obtained in other monitoring studies of organochlorine pesticides in breast milk in comparison with the results obtained from this monitoring survey are presented in (Table 3). The total DDT and total HCH were higher than those reported in Italy, but lower than those found in other countries. On the other side, levels of total DDT and total HCH detected in present study were lower than those found in other countries.

Estimated dietary intakes (EDIs):

Estimation of dietary intake of organochlorines pesticides by the breast–fed infants could be derived from breast milk data. Whereas, an infant consumes an average of 120 g of breast milk per kg body weight

per day for the first 3 months of life, as well as the volume consumed per unit weight decreases with increasing age (WHO, 1985). The results recorded in Table 6 indicated that EDIs of organochlorine pesticides by breast – fed infants were generally below the established ADIs for DDT complex and (-HCH (lindane) but the EDIs for Endrin + dieldrin exceeded the ADI established by FAO / WHO (1988). However, the ADI has not been established for (α+ β) HCH and DDT compound.

These data indicated higher exposure of mothers and consequently their infants to DDT and lindane. The results of the present study are consistent with notion that general population exposure to organochlorines is the result of widespread food contamination. The concentration obtained were below those associated with over toxicity in the mothers. On the other side Rogan *et al.*, (1986) calculated that a child breast – feeding for eight months would have a body burden of about 8 mg. Pico *et al.*, (1995) calculated the daily intakes from the median and maximal concentrations of the compounds. The values obtained were 2.28 and 5.43 g/kg/day for DDT. In developing nations the estimated DDT intake by infants was at least 100 fold greater than the ADI of the FAW/WHO (Kannan *et al.*, 1997). In Egypt Dogheim *et al.* (1996b) recorded that EDIs of DDT by 85.96 % and 57.8 % of the ADI in Kafr El-zayat and Cairo, respectively. Dogheim *et al.* (1991) mentioned that EDI of organochlorines were generally below ADI, but EDI for dieldrin exceeds its ADI (1220%). El-Sayed Abd Alla *et al.* (1998) reported that EDIs were 2280%, 650% and 575 % of ADI in Aswan, Cairo and El–Menia respectively, whereas EDIs of γ-HCH was below the ADI. EDIs of endrin + dieldrin exceeded its ADI.

In conclusion, it is recommended to measure and evaluate the actual total intakes of organochlorine pesticide residues consumed in Egyptian diet. Pesticide residues in foodstuffs should be monitored in order to ensure that public health is not endangered by residue concentrations that are in excess of the official tolerance levels.

From the forgoing attention must be given to the fact that the contamination levels are above the established FAO/WHO tolerance limits of DDT, HCH and dieldrin in food samples analyzed. The study showed the need to continue monitoring pesticide residues in food for human consumption in order to improve food safety, since these contaminants represent a potential risk to human health because of their accumulation linked to potential hormone – disruption effects.

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Table 1: Incidence and levels of organochlorine pesticides residues (ppm – fat) Bolti fish (Tilapia) collected from some Egyptian Governorates during 1999-2000.

Governorate / Pesticides	Assiut (n=16)			El-Monifiah (n=7)		
	Frequency %	Mean[b]	Highest level	Frequency %	Mean[b]	Highest level
Aldrin	0.0	0.0	0.0	0.0	0.0	0.0
Endrin	12.5	0.43	0.82	71.4	0.154	0.41
Dieldrin	12.5	0.03	0.04	57.1	0.20	0.53
Σ Endrin + dieldin	**12.5**	**0.23**	**0.43**	**64.25**	**0.177**	**0.47**
α- HCH	18.75	0.32	0.61	42.9	1.13	2.4
β-HCH	12.5	0.28	0.51	42.9	1.5	2.7
γ-HCH (Lindane)	18.75	0.34	0.92	57.1	2.13	6.2
Σ HCH	**16.5**	**0.13**	**0.68**	**47.63**	**1.59**	**3.77**
P′, P′- DDT	56.25	3.8	10.1	42.9	1.96	3.11
P′, P′- DDD	37.5	0.56	1.12	42.9	0.14	0.31
P′, P′- DDE	31.25	0.49	1.09	42.9	0.103	0.14
Σ DDT	**41.65**	**1.62**	**4.10**	**42.9**	**0.73**	**1.27**
Heptachlor – epoxide	0.0	0.0	0.0	14.3	0.08c	0.08

Table 2: Level of pesticides residues (ppm-fat) in domestic hard cheese (Ras cheese)

Governorate / Pesticides	Cairo (n [a] = 15)			Domitta (n [a] = 15)			Assiut (n [a] = 15)		
	Frequency %	Mean[b]	Highest level	Frequency %	Mean[b]	Highest level	Frequency %	Mean[b]	Highest level
Aldin	0.0	nd	nd	0.0	Nd	nd	0.0	nd	nd
Endrin	33.3	0.37	0.72	20	0.17	0.41	40	0.51	0.91
Dieldrin	26.7	0.235	0.51	0.0	Nd	nd	13.33	0.21	0.33
Endrin + Dieldrin		0.24			0.085			0.36	
α- HCH	20.0	0.59	1.1	26.7	0.42	0.9	13.33	1.05	1.2
β-HCH	13.3	0.89	1.37	0.0	Nd	nd	0.0	nd	nd
γ-HCH (Lindane)	33.3	1.15	4.1	26.7	0.38	1.2	40	1.2	5.2
Σ HCH		0.887			0.271			0.75	
P′, P′- DDT	46.7	1.78	6.12	33.3	1.31	4.21	53.33	1.91	7.22
P′, P′- DDD	0.0	0.0	0.0	0.0	0.0	0.0	26.7	0.014	0.016
P′, P′- DDE	20.0	0.76	2.1	20	0.096	0.21	33.33	0.28	0.9
Σ DDT		0.85			0.47			0.73	
Heptachlor – epoxide	6.7	0.05	0.05	0.0	Nd	nd	0.0	nd	nd

n.d.= not detected a: number of samples analyzed b: mean of positives samples

Table 3: Organochlorine pesticides in Breast milk [a] in Egypt.

Pesticides	Frequency	Range (ppb)	Mean – Positives (ppb)
P′, P′ - DDT	6/10 (60%)	8 – 144	56.7
P′, P′ - DDE	1/10 (10%)	n.d – 72	72[b]
P′, P′ - DDD	4/10 (40%)	7 – 320	154.74
Total DDT complex	**6/10 (60%)**	**17 – 176**	**79.2**
α- HCH	5/10 (50%)	5 – 31	13.0
β-HCH	2/10 (20%)	4 – 15	9.5
γ-HCH (Lindane)	3/10 (30%)	21 – 41	28
Total HCH isomers	**5/10 (50%)**	**12 – 72**	**33.6**
Aldrin	0.0 (0.0%)	0.0	0.0
Endrin	2/10 (20%)	13 – 42	27.5
Dieldrin	1/10 (10%)	n.d – 6	6[b]
Σ Endrin + dieldrin	**3/10 (30%)**	**19 - 42**	**30.5**

a: total number of analyzed samples were 10 samples.
b: only one sample was positive.

Table 4: Mean concentrations of Σ DDT and Σ HCH (ppb) in human milk from different countries

Country	Year	Σ DDT(ppb)	Σ HCH (ppb)	Reference
Japan	1977	1900	2500	Yakushiji *et al.* (1979)
United States	1980	2200	180	Takei *et al.* (1983)
Great Britain	1980	1900	220	Collins *et al.* (1982)
Mexico	1981	4410	400	Slorach and Vaz (1983)
China	1982	6200	6600	Slorach and Vaz (1983)
Israel	1984	2800	390	Weisenberg *et al.* (1985)
W.Germany	1984	1900	450	Deutsche Forschungsgemeinschaft (1986)
Kenya	1985	6900	110	Kanja *et al.* (1986)
Canada	1987	1000	220	Davies and Mes (1987)
Turkey	1987	5800	1000	Karakaya *et al.* (1987)
India	1990	1200	6200	Tanabe *et al.* (1990)
Italy	1993	74.5	10	Larsen *et al.* (1994)
Turkey	1993	2869	758	Basri *et al.* (1994)
Norway	1993	338	36	Johansen *et al.* (1994)
Egypt, Cairo	1987	57.6	9.5	Dogheim *et al.* (1991)
Egypt, Cairo	1994	96.4	193.5	Dogheim *et al.* (1996)
Egypt, Kafr El – Zayat	1994	143.2	115.97	Dogheim *et al.* (1996)
Egypt	1998	194.8	67	Abd Alla *et al.* (1998)
Egypt present study	2002	79.2	33.6	Abd Alla *et al.*

Table 5: Maximum residue limits (MRL, ppm – milk fat) of some pesticides in milk and dairy products *(Dabiza et al., 1999)*

Pesticides	E.U*	FAO / WHO**	*E.R****
Aldrin + dieldrin	0.006	0.006	0.006
α- HCH	004	- - -	- - -
β-HCH	0.003	- - -	- - -
γ-HCH (Lindane)	0.008	0.01	0.01
Σ HCH	-	0.1[(a)]	
DDTs	0.04	0.05	0.00
Heptachlor	-	0.006	-
Diazinon	0.01	0.02	0.02

* = European union limits **(Losada *et al.*, 1996)**
** = FAO / WHO, **(1993):** plant production and protection paper, 122: 31-33
*** = Egyptian standard for maximum residue limits of pesticides in foods (1991 – 1992)
(a) : Waliszewski, *et al.*, (1998)

Table (6): Estimated dietary intakes (EDIs) of organochlorine pesticides residues by breast – fed infants and corresponding acceptable daily intakes (ADIs)

Pesticides	EDI µg / kg body weight / day	FAO / WHO ADI[a], µg / kg body Weight	EDI of ADI %
DDT	6.8	- - -[b]	- - -
DDT complex	9.5	20.0	47.5
Endrin + dieldrin	3.66	0.1	3360
HCH gamma - isomer (lindane)	3.36	10.0	33.6
HCH, (α + β) – isomers	2.7	- - -[c]	- - -
- HCH complex	4.03	- - -[b]	- - -

a: ADIs cited here reflect revision made in 1987
b: ADI not established c: ADI for (α + β) HCH was wikdrawn by WHO.